Supplementary material

When and where does near-surface runoff occur in a pre-Alpine headwater catchment?

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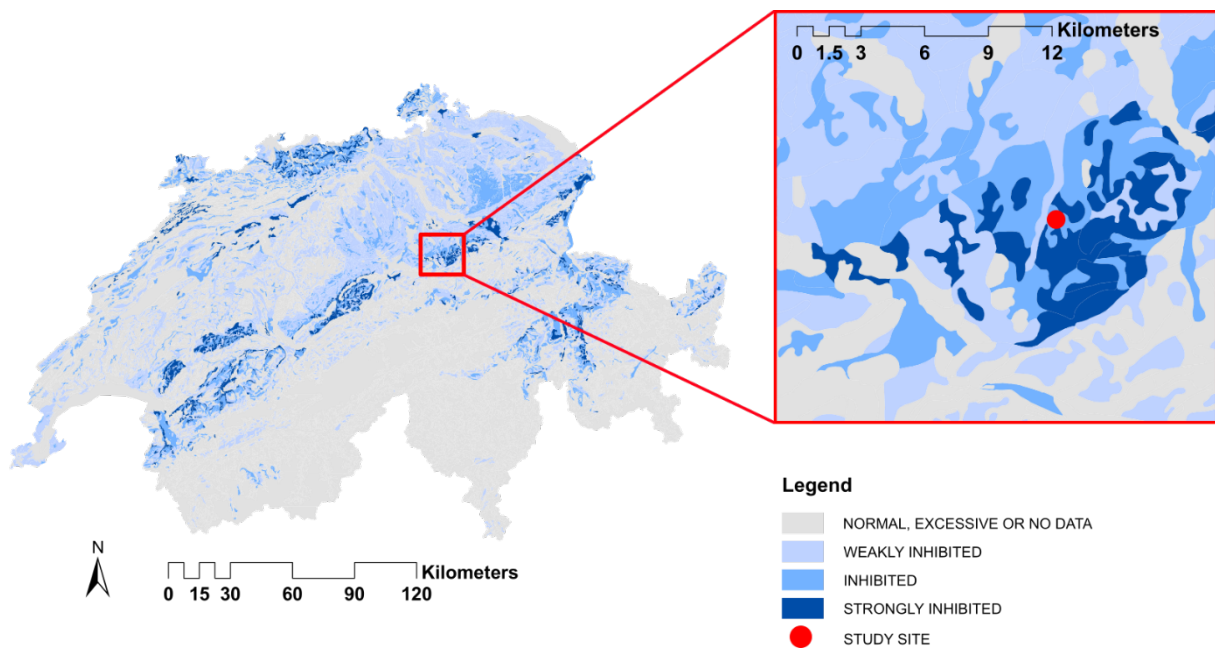
10   **Figure S1: Map of Switzerland showing areas with inhibited vertical drainage in the upper 0.50 m of the soil profile (in different shades of blue) and the location of the Studibach. Data: Carte des aptitudes des sols de la Suisse OFAG [BLW, 1980].**

15   **Figure S2: Photos of the plots: location C3.7 (red rectangle 1x3m) showing the typical cover of the open coniferous forest in the lower catchment C3 (a), the location C5.2 (b), and C2.1 (c).**

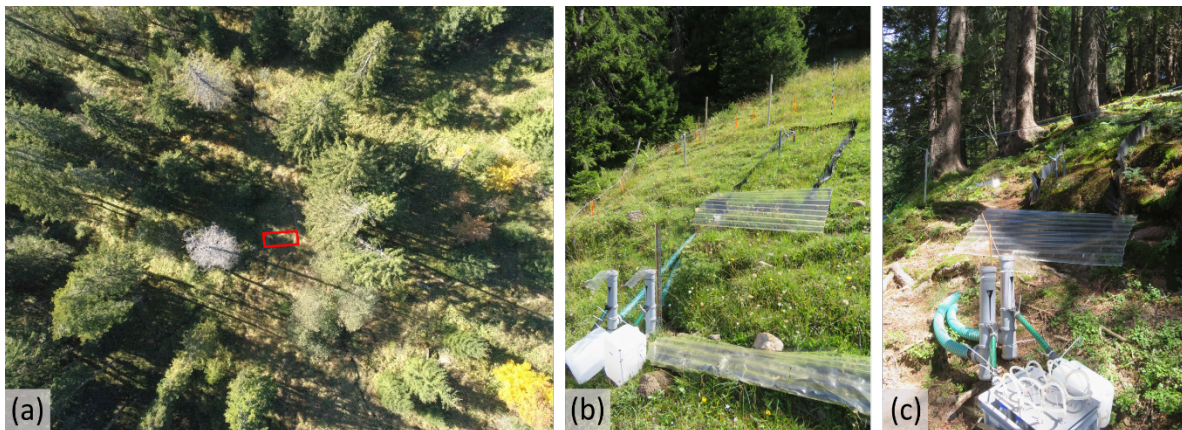



Figure S3: Photos of the plot setup, showing the trench with the drainage mat (a), gutter covered with a roof and plot borders (b), and the hoses connecting the runoff plot to the UBeTubes in the back (c) for plot C2.5.

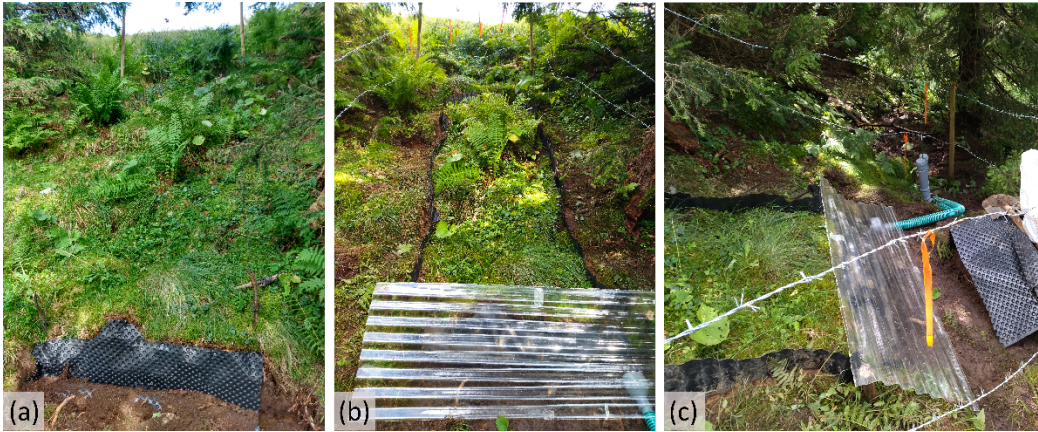



Figure S4: Photos of the UBeTubes in the field (a), and a sketch of the UBeTubes with the dimensions (b).

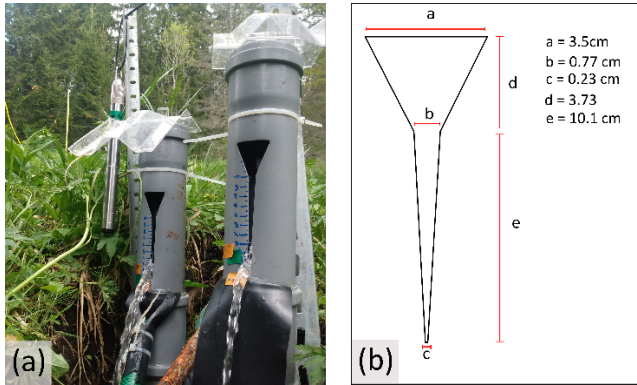



Table S1: Characteristics of the 27 events: *P*: total precipitation (mm), I_{10}: 10-min maximum precipitation intensity (mm h^{-1}), I_{mean}: mean precipitation intensity for every 30 min period with precipitation (mm h^{-1}), I_{class}: precipitation intensity class; *D*: event duration (time between the start and end of the event; h), *ASI*: antecedent soil moisture index for the top 5 cm of soil (mm), *ASI+P*: antecedent soil moisture index plus total precipitation (mm), P_{OF}: percentage of plots for which there was a measurable amount of OF, P_{TIF}: percentage of plots for which there was a measurable amount of TIF.

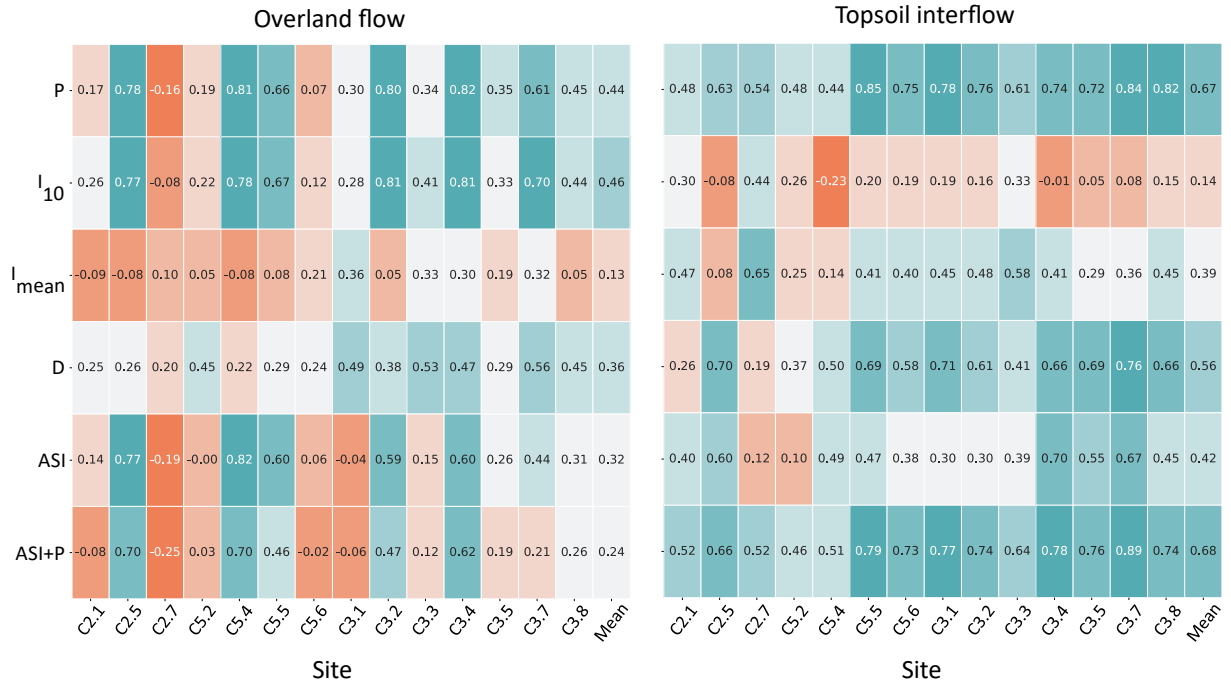
Event	Date	P	I_{10}	I_{mean}	I_{class}	D	ASI	ASI+P	P_{OF}	P_{TIF}
-	dd/mm/yy	(mm)	(mm/h)	(mm/h)	-	(hh:min)	(mm)	(mm)	%	%
E1	31/05/22	7	5.4	1.8	Low	03:15	22	98	0	0
E2	03/06/22	20	34.8	5.1	High	03:05	24	31	40	40
E3	05/06/22	17	39.6	2.9	Medium	04:15	24	45	20	40
E4	06/06/22	43	49.8	2.5	Medium	11:45	24	42	75	100
E5	09/06/22	22	15.6	2.0	Low	06:35	25	68	40	40
E6	12/06/22	11	15.6	2.3	Medium	02:35	26	48	20	0
E7	24/06/22	38	63.0	5.4	High	05:35	24	34	67	92
E8	27/06/22	10	13.2	1.9	Low	03:25	23	61	25	33
E9	30/06/22	49	27.6	3.6	Medium	10:35	23	33	80	100
E10	20/07/22	10	28.2	2.8	Medium	02:05	24	72	43	15
E11	25/07/22	20	22.8	2.1	Medium	05:45	16	26	50	46
E12	28/07/22	5	4.8	2.5	Medium	01:55	18	38	29	8
E13	29/07/22	9	4.8	1.8	Low	04:15	21	26	36	23
E14	01/08/22	7	16.8	1.9	Low	02:25	22	31	14	0
E15	15/08/22	28	48.0	5.6	High	03:35	20	28	79	83
E16	18/08/22	98	25.2	6.5	High	13:50	17	45	86	92
E17	26/08/22	9	15.6	3.1	Medium	02:35	25	123	50	50
E18	27/08/22	12	48.6	3.8	Medium	01:25	21	30	14	7
E19	30/08/22	20	22.2	3.0	Medium	07:05	22	33	93	86
E20	02/09/22	8	34.8	1.9	Low	01:40	24	44	7	7
E21	06/09/22	29	30.0	4.1	High	05:45	23	31	79	93
E22	14/09/22	20	25.2	2.5	Medium	05:35	24	53	50	64
E23	16/09/22	51	10.2	2.0	Low	19:55	23	42	57	83
E24	26/09/22	18	12.0	1.6	Low	08:45	25	75	57	79
E25	01/10/22	34	7.2	2.0	Low	13:45	24	43	43	67
E26	02/10/22	25	11.4	2.2	Medium	09:25	24	58	64	77
E27	08/10/22	6	7.8	0.9	Low	07:25	24	50	8	22

Table S2: Correlation matrix showing the Spearman rank correlation between the event characteristics and the statistical significance of the relation (*: p:0.05-0.1; **: p:0.01-0.05; ***: p<0.01). *P*: total precipitation (mm), *I$_{10}$*: 10-min maximum precipitation intensity (mm h^{-1}), *I$_{mean}$*: mean precipitation intensity for every 30 min period with precipitation (mm h^{-1}), *D*: event duration (time between the start and end of the event; h), *ASI*: antecedent soil moisture index for the top 10 cm of soil (mm), *ASI+P*: Antecedent soil moisture index plus precipitation (mm).

	P	I$_{10}$	I$_{mean}$	D	ASI	ASI+P
P	-	0.39**	0.53***	0.77***	0.50***	0.96***
I$_{10}$		-	0.70***	-0.04	-0.11	0.30
I$_{mean}$			-	-0.05	-0.06	0.42**
D				-	0.69***	0.83***
ASI					-	0.65***
ASI+P						-

Table S3: Correlation matrix showing the Spearman rank correlation between the site characteristics and the statistical significance of the relation (*: p: 0.05-0.1; **: p:0.01-0.05; *; p<0.01).**

	TWI	Slope	Vegetation	Depth A horizon	Depth B horizon	OM (%)
TWI	-	-0.27	0.60**	0.42	0.01	0.56**
Slope		-	-0.44	-0.35	0.25	-0.39
Vegetation			-	0.02	-0.18	0.30
Depth A horizon				-	0.02	-0.40
Depth B horizon					-	0.36
OM (%)						-

Figure S5: Heatmap of the Spearman rank correlation between the runoff ratio for OF (left) and TIF (right) and five event characteristics for each location as well as the average for all locations: *P*: total precipitation (mm), *I_{10}*: 10-min maximum precipitation intensity (mm h⁻¹), *I_{mean}*: mean precipitation intensity for every 30 min period with precipitation (mm h⁻¹), *D*: event duration (time between the start and end of the event; h), *ASI*: antecedent soil moisture index for the top 5 cm of soil (mm), *ASI+P*: antecedent soil moisture index plus precipitation (mm).

50 **Figure S6: Heatmap of the Spearman rank correlation between the percentage of events for which there was a measurable amount of overland flow (OF) (a: top) or TIF (b: bottom) and five site characteristics for each event for which OF was recorded at more than 4 plots (ordered by *ASI+P*; x-axis), and the mean for all events: topographic wetness index (TWI), vegetation, slope and organic matter content (OM (%)).**

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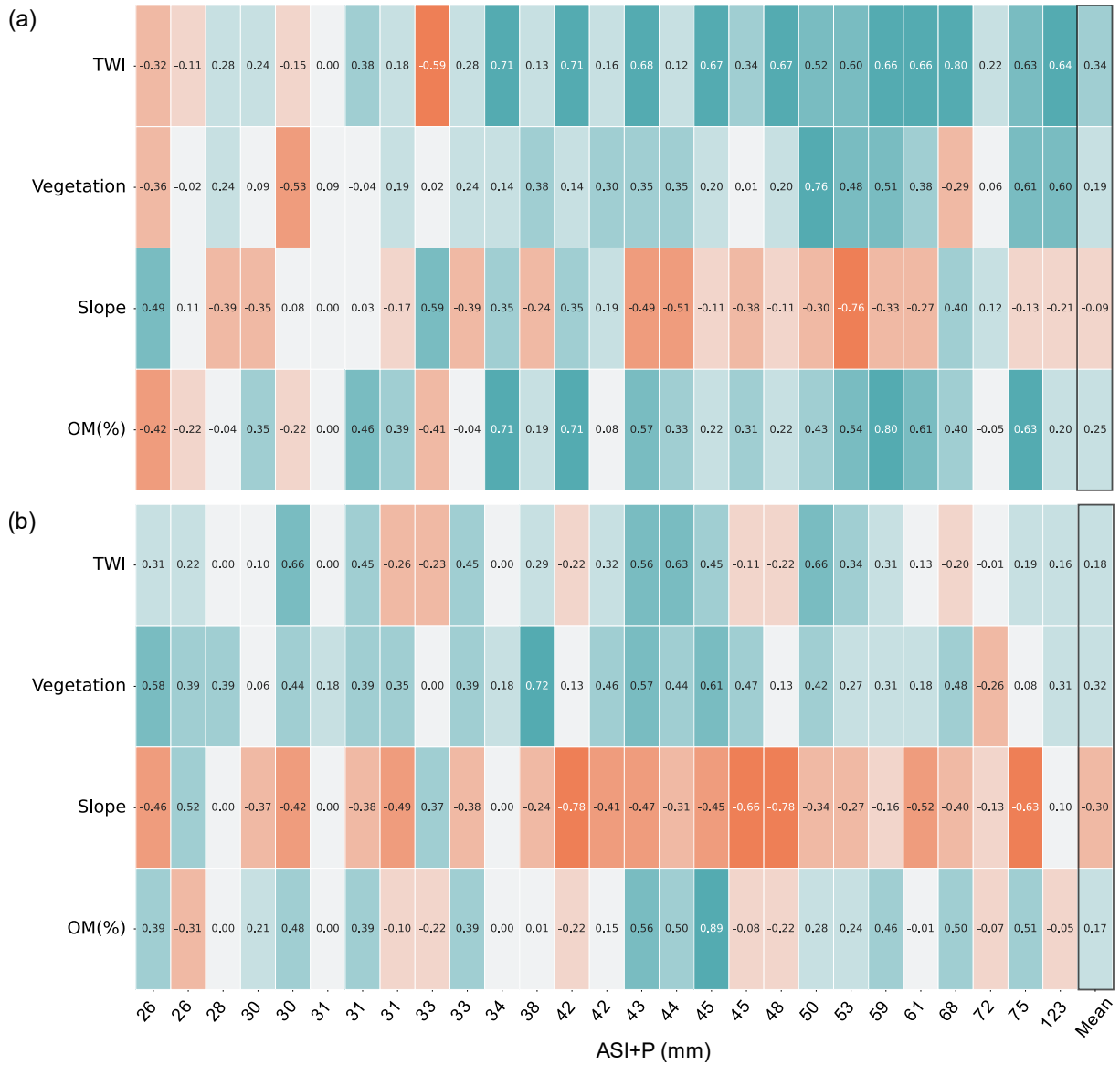


Figure S7: Heatmap of the Spearman rank correlation between the fraction of OF per plot for near surface flow for each event and five plot characteristics for each event for which there was a measurable amount of OF and TIF (ordered by *ASI+P*) and the mean for all events: topographic wetness index (TWI), vegetation, slope and organic matter content (OM (%)).

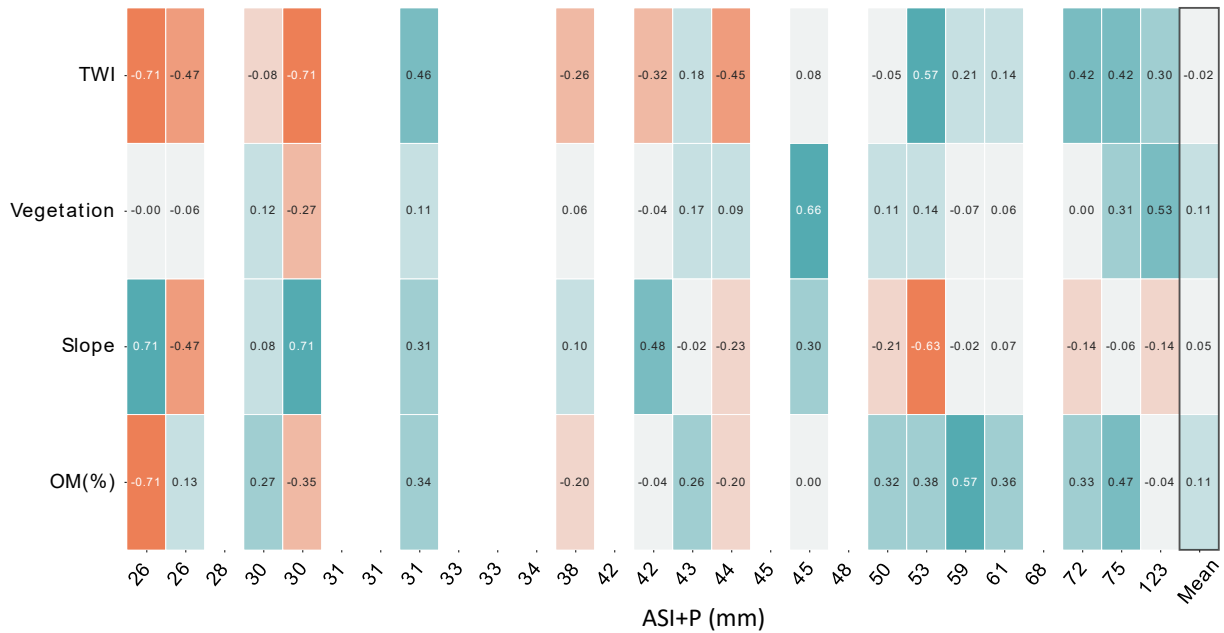



Figure S8: Heatmap of the runoff ratio (*R*) for OF (left) and TIF (right) for each event (ordered by total precipitation; x axis) and each plot (y axis). All runoff ratios >1 were set to 1 for plotting. Events for which no flow occurred are shown in white. Events for which data are missing are indicated by the shaded area.

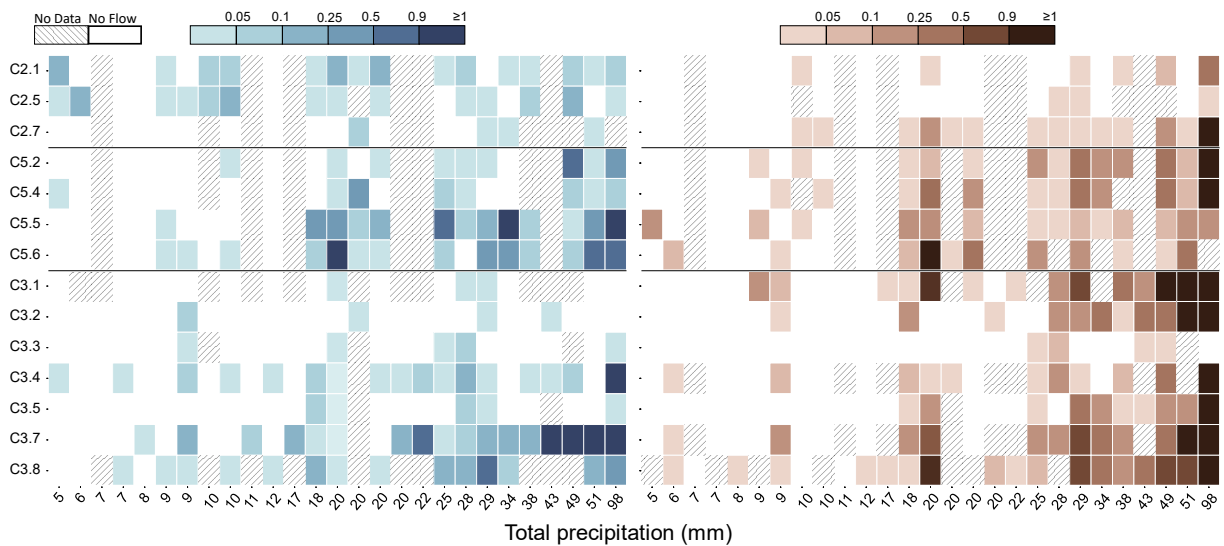



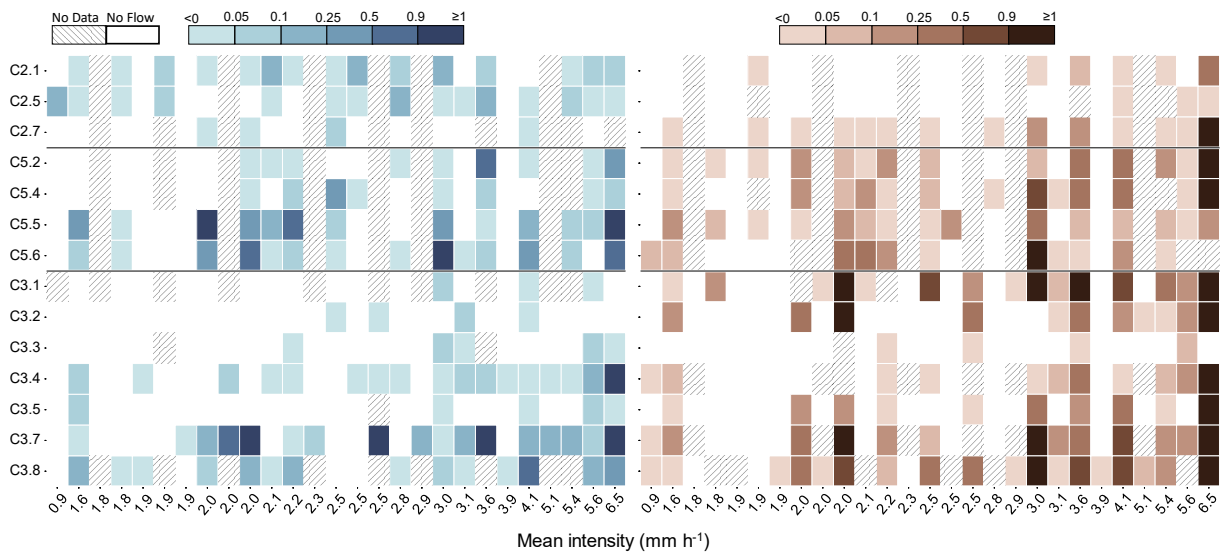
Figure S9: Heatmap of the runoff ratio (*R*) for OF (left) and TIF (right) for each event (ordered by mean intensity; x axis) and each plot (y axis). All runoff ratios >1 were set to 1 for plotting. Events for which no flow occurred are shown in white. Events for which data are missing are indicated by the shaded area.

Mean intensity (mm h^{-1})

Figure S10: Hydrographs for overland (OF; blue) and topsoil interflow (TIF; brown) for each plot during the 20 mm event on 30 August 2022 (event E20), as well as precipitation intensity (mm 10min⁻¹; only shown for the upper row of figures). The plot name is indicated above each subplot. Data for plot C3.2 are missing due to logger malfunctioning.

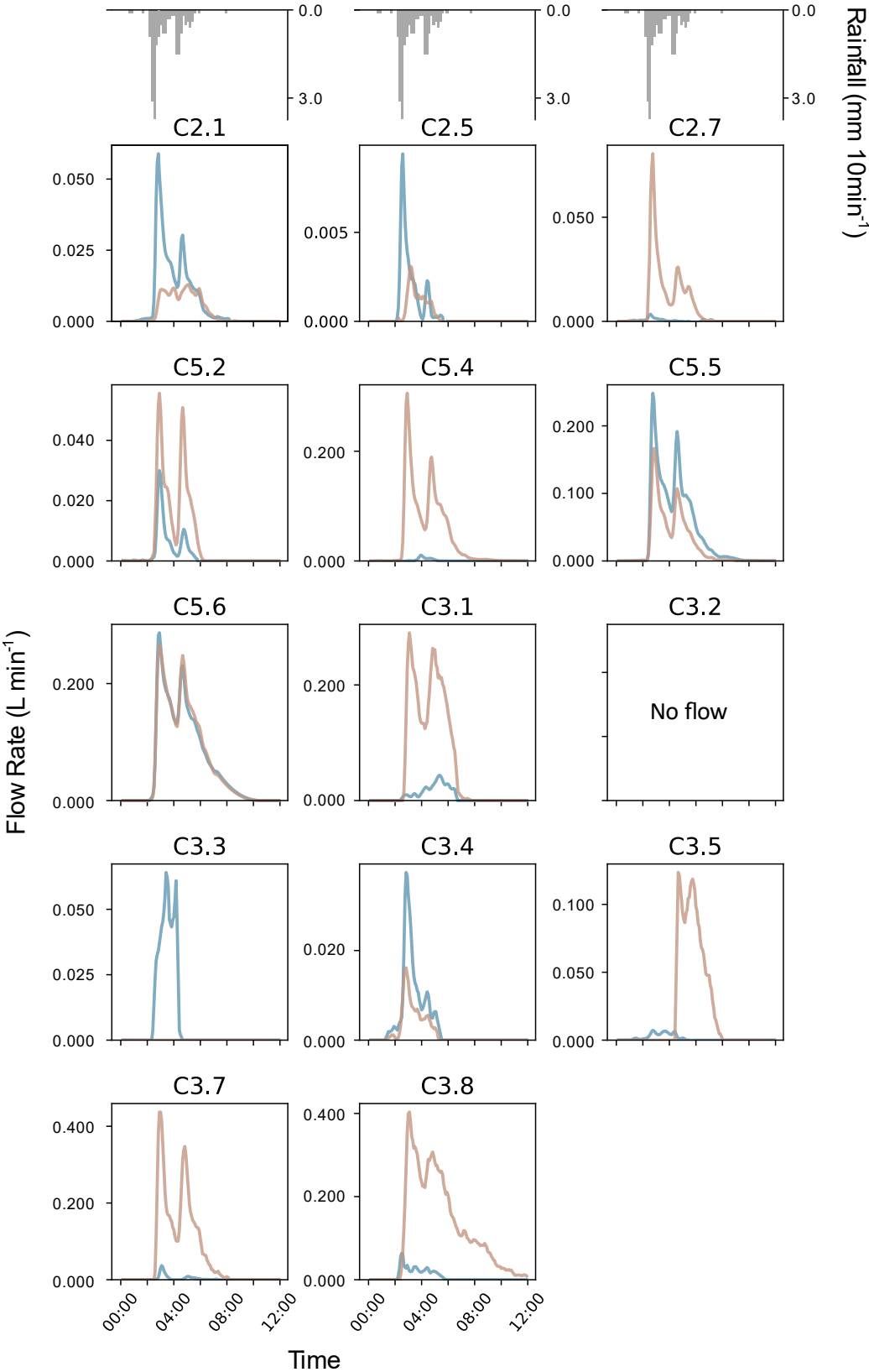



Figure S11: Heatmap showing whether overland flow (OF, blue) or topsoil interflow (TIF, brown) peaked first or if both responded within 5 min (same time, gray) for each rainfall event (ordered by increasing *ASI+P*; x-axis) and plot (y-axis). Dashed lines indicate the lack of OF and TIF for that particular event, while white cells indicate a lack of data for either OF or TIF.

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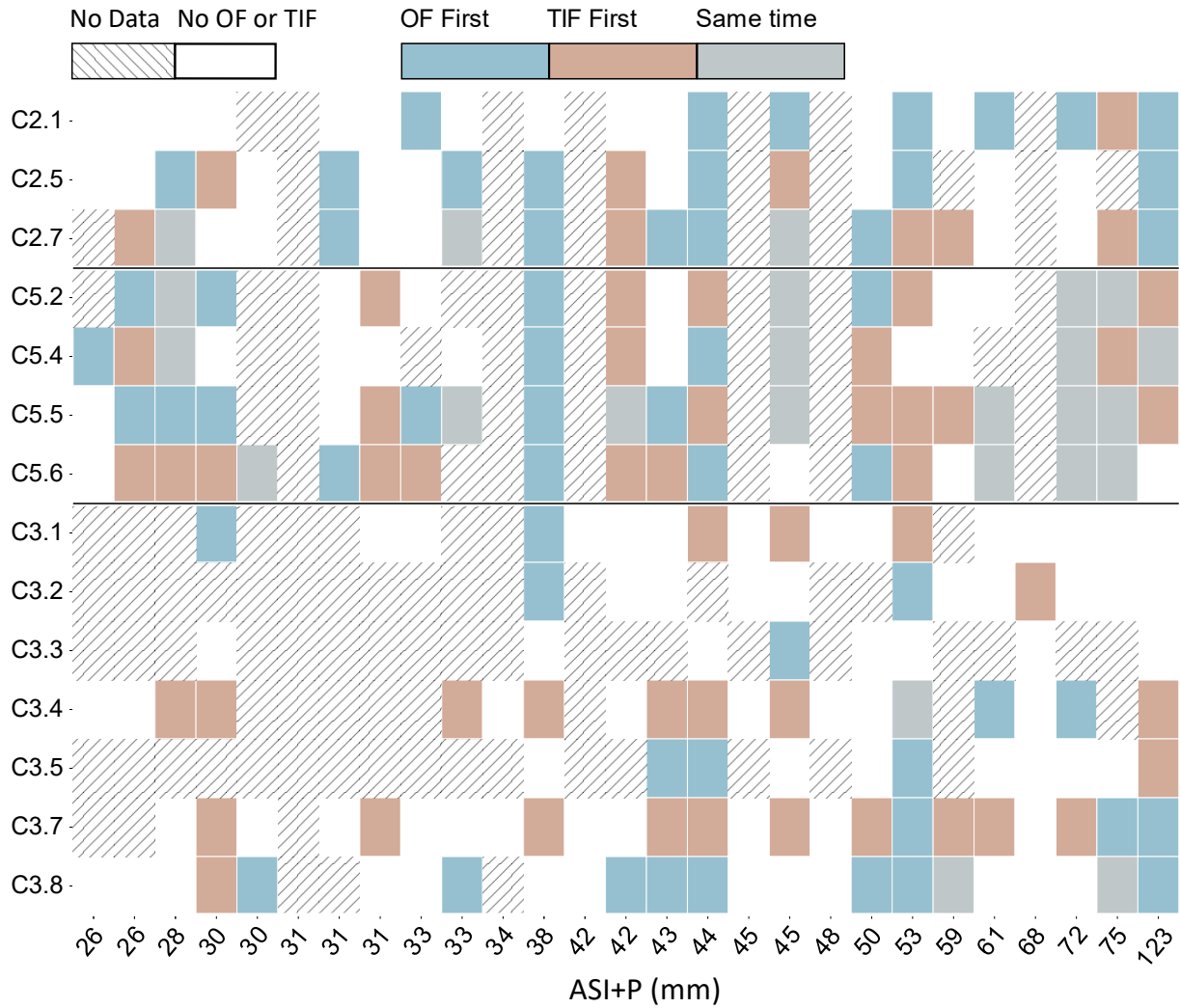
Figure S12: Heatmap showing whether overland flow (OF, blue) or topsoil interflow (TIF, brown) responded first or if both responded within 5 min (same time, gray) for each rainfall events (ordered by increasing mean intensity in x-axis) and plot (y-axis). Dashed lines indicate the lack of OF and TIF for that particular event, while white cells indicate a lack of data for either OF or TIF.
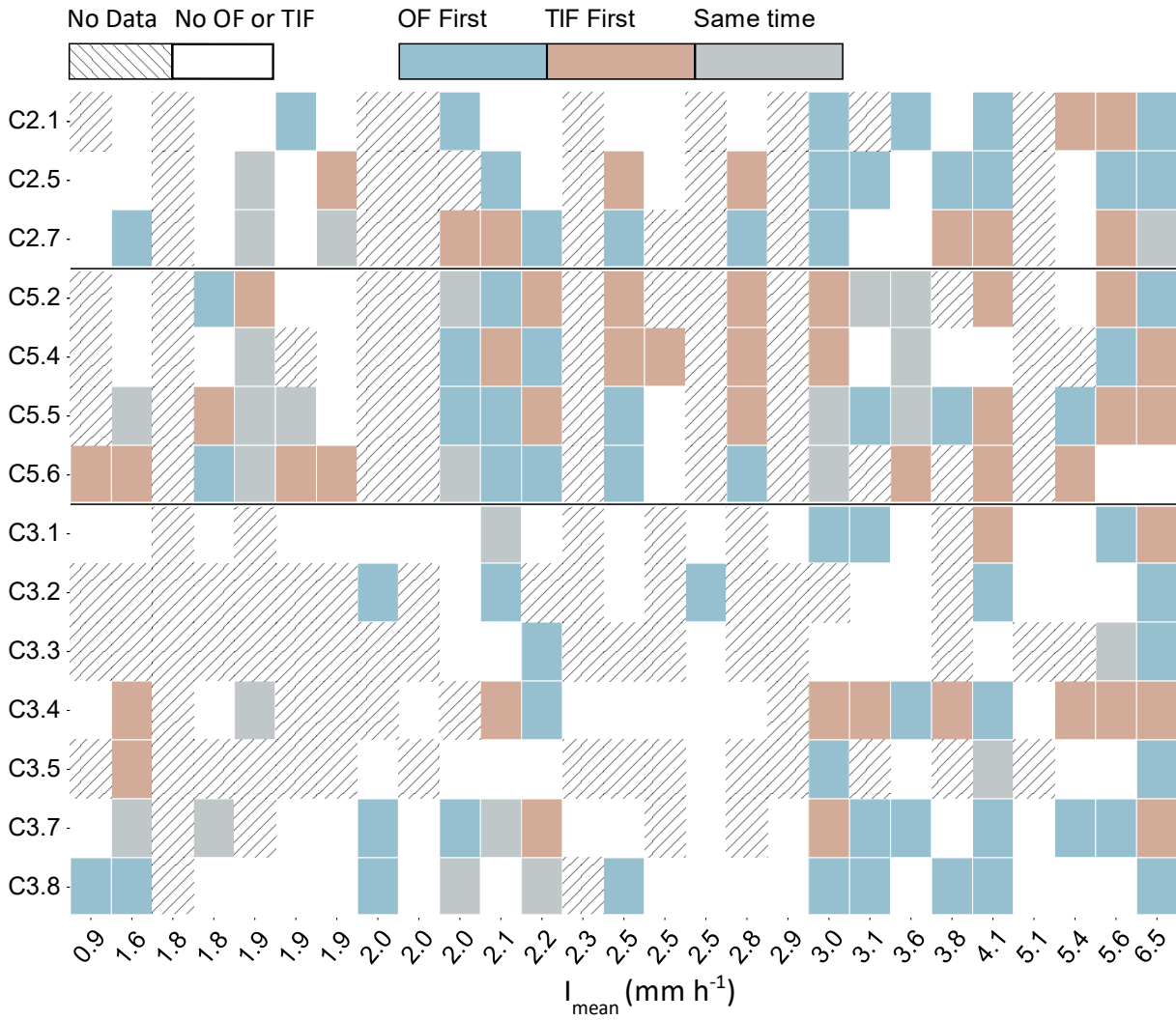
Figure S13: Heatmap showing whether overland flow (OF, blue) or topsoil interflow (TIF, brown) peak first or if both responded within 5 min (same time, gray) for each rainfall events (ordered by increasing mean intensity in x-axis) and plot (y-axis). Dashed lines indicate the lack of OF and TIF for that particular event, while white cells indicate a lack of data for either OF or TIF.